Remarks

Allowance of all pending claims is respectfully requested. Claims 1-7, 10-14 & 30-35 remain pending. Initially, Applicants gratefully acknowledge the indication of allowability of claims 1-7, 10-14 and 34. This amendment and the following remarks are addressed to the remaining claims 30-33 & 35.

Specifically, claim 30 is amended to specify that the first solder bumps comprise first reflowed solder bumps and the second solder bumps comprise second reflowed solder bumps, and that the second reflowed solder bumps have at least a portion that melted at a lower temperature than the first reflowed solder bumps, with the second reflowed solder bumps comprising alignment solder bumps which when melted aligned the first substrate to the second substrate before melting of the first reflowed solder bumps. Support for the amendments to this independent claim can be found throughout the application as filed, including allowed independent claim 1. No new issues are believed raised by the claim amendment submitted herewith since amended claim 30 is drawn to the allowable subject matter noted at page 5 of the final Office Action. As amended, claims 30-33 & 35 are believed in condition for allowance.

In the Office Action, claims 30 & 35 were rejected under 35 U.S.C. §102(e) as being anticipated by Downes (U.S. Patent No. 6,222,277), and claims 30-33 & 35 were rejected under 35 U.S.C. §102(b) as being anticipated by Koiwa et al. (U.S. Patent No. 5,907,187; hereinafter Koiwa). These rejections are respectfully traversed to any extent deemed applicable to amended claim 30 presented herewith.

Current solder bump array deposition technologies require an expensive and time consuming mask alignment process. This alignment process becomes increasingly difficult and costly as the solder bump size and pitches decrease. To realize the full advantages of multi-chip stack technology, very high solder bump interconnect density is needed. Unfortunately, the multi-chip stack structure may suffer the expensive and inherent technology limitations associated with current solder bump array technologies. Applicants claimed invention is designed to address these inherent limitations by providing a self-aligning interconnect structure.

As recited in claim 30, for example, Applicants' invention comprises a structure which has a first substrate and a second substrate, and first reflowed solder bumps and second reflowed solder bumps offset therebetween. The first reflowed solder bumps and the second reflowed solder bumps are separate solder bumps disposed between the first substrate and the second substrate, and the second reflowed solder bumps have at least a portion that melted at a lower temperature then the first reflowed solder bumps. Further, functionality is recited to the effect that the second reflowed solder bumps comprise alignment solder bumps which aligned the first substrate and the second substrate before the first reflowed solder bumps were melted. Applicants recited structure of independent claim 30 is clearly distinct from the teachings and suggestions of both Downes and Koiwa.

It is well settled that there is no anticipation of a claim unless a single prior art reference discloses: (1) all of the same elements of a claimed invention; (2) found in the same situation as the claimed invention; (3) united in the same way as the claimed invention; and (4) in order to perform the identical function of the claimed invention. In this instance, both Downes and Koiwa fail to disclose various elements of Applicants' invention as recited in amended independent claim 30, and as a result, do not anticipate (or even render obvious) Applicants' invention.

Downes discloses a non-collapsing stand-off for semiconductor devices. The structure includes a plurality of balls formed of a first solder alloy disposed on the bottom surface of the semiconductor substrate and projecting downwardly therefrom. Each of the plurality of balls is sized to support the weight of the semiconductor substrate. The structure also includes a plurality of solder joints formed of a second solder alloy connecting the plurality of balls to the corresponding plurality of wettable pads on the printed circuit board. The first solder alloy has a liquidus temperature greater than the second solder alloy liquidus temperature, and the second solder alloy has a liquidus temperature suitable for use with the material comprising the printed circuit board and the semiconductor substrate. The material comprising the printed circuit board and the semiconductor substrate are thermally degradable at a temperature greater than the liquidus temperature of the second solder alloy and less than the liquidus temperature of the first solder alloy. (See Abstract of Downes.)

Initially, Applicants note that Downes does not discuss the problem addressed by the present invention (i.e., how to achieve better alignment of fine pitched solder bumps). Rather, Downes is addressing how to establish a minimum fixed spacing between a semiconductor substrate and a printed circuit board using an interconnect structure. In Downes, this is achieved by providing a first plurality of balls 40 of a first solder alloy having a liquidus temperature greater than the liquidus temperature of a second plurality of solder balls 41. As explained in Downes, the temperature to which the assembly is heated always remains below the liquidus temperature of the solder alloy comprising the plurality of balls 40. (See Col. 9, lines 35-59.)

In contrast, Applicants' amended claim 30 characterizes the first solder bumps and the second solder bumps as first reflowed solder bumps and second reflowed solder bumps, respectively. In Applicants' invention, both types of solder bumps are reflowed. Downes thus expressly teaches away from Applicants' invention by indicating that the plurality of solder balls 40 are not to be melted. In fact, if one were to propose a modification in Downes to melt solder balls 40, then the intended purpose of Downes would be negated.

Still further, Applicants recite that the second reflowed solder bumps comprise alignment solder bumps which aligned the first substrate and the second substrate before the first reflowed solder bumps are melted (claim 30). Applicants respectfully submit that Downes does not teach or suggest this functionality. As noted above, the first plurality of solder balls 40 in Downes are not to be reflowed (contrary to Applicants' recited structures). In Applicants' invention, the reflowing of the second solder bumps provides a further level of alignment between the first and second substrates prior to reflowing of the first solder bumps.

In this regard, Applicants respectfully traverse the conclusion at page 3 of the Office Action (and subsequent pages) that Applicants' Best Mode discussion, which discloses the recognition that the reflow process inherently causes alignment, can be employed to reject their claimed invention. Applicants respectfully submit that this justification does not identify an adequate teaching or suggestion in Downes which would indicate their claimed invention as being anticipated thereby. Applicants respectfully submit that the only suggestion for reflowing the second solder bumps to provide another level of alignment between a first and second substrate is disclosed in Applicants' own specification, which as well known, cannot be used as a

reference against their claimed invention. It is Applicants who have discovered that reflowing of second solder bumps as recited in independent claim 30 provides a further level of alignment between the first and second substrate which further facilitates precise alignment of the first solder bumps, before the first solder bumps are melted.

For the above reasons, Applicants respectfully submit that amended independent claim 30 patentably distinguishes over the teachings of Downes. Reconsideration and withdrawal of the rejection based thereon is therefore requested.

Koiwa describes an electronic component and electronic component connecting structure which includes groups of connecting bumps. The groups of connecting bumps comprise connecting bumps made of high temperature solder or connecting bumps made of a high strength In type solder in the part of formation thereof. The connecting bumps of high temperature solder are not directly affected by the influence of displacement because they retain the shape of a ball even after the step of connecting such as solder reflow. The connecting bumps made of In type solder form connecting parts of high strength. These groups of connecting bumps contribute to exalt the reliability of the connecting parts without decreasing the number of input and output terminals. (See Abstract of Koiwa.)

Initially, Applicants respectfully submit that a careful reading of Koiwa fails to uncover any teaching or suggestion of Applicants' structure as recited in amended claim 30. In Applicants' amended claim 30, the first solder bumps and the second solder bumps are characterized as first reflowed solder bumps and second reflowed solder bumps, respectively. Both types of solder bumps are reflowed, which as noted initially, comprises the allowable subject matter of claim 1 as indicated in the Examiner's Office Action. Koiwa expressly teaches away from such a structure by indicating that the mechanical stand-off solder bumps (FIG. 2, element 10b) do not melt on reflow. That is, in Koiwa, the reflow thermal profile is such that the liquidus temperature is exceeded only for the low temperature bumps (see element 10a of FIG. 2). One distinction with Downes is that a low-temperature solder fillet (FIG. 1, element 5) is employed in Koiwa to solder the high-temperature ball (FIG. 2, element 10b) to the connection pad (FIG. 1, element 4). This low-temperature solder fillet material is the same as the low-

temperature solder bump (FIG. 1, element 6a). Thus, the low temperature solder fillet and the low temperature solder bump reflow at the same temperature.

Further, Applicants recite that the second reflowed solder bumps comprise alignment solder bumps which align the first substrate and the second substrate before the first reflowed solder bumps were melted. Applicants respectfully submit that Koiwa does not teach or suggest this aspect. As noted above, the mechanical stand-off solder bumps in Koiwa are not to be reflowed (contrary to Applicants' recited structure). In Applicants' invention, the reflowing of the second solder bumps provides a further level of alignment between the first and second substrates prior to reflowing of the first solder bumps.

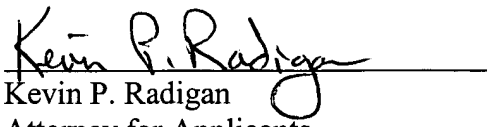
In view of the differences noted above, Applicants respectfully submit that their invention as recited in independent claim 30 would not have been anticipated (or even rendered obvious) by the structures of Koiwa. Therefore, reconsideration and withdrawal of the anticipation rejection based thereon is respectfully requested.

The dependent claims are believed patentable for the same reasons as the independent claim from which they directly or ultimately depend, as well as for their own additional characterizations.

The application is believed to be in condition for allowance, and such action is respectfully requested.

Applicants' undersigned attorney is available should the Examiner wish to discuss this application further.

Respectfully submitted,



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